

CLAIMS

We claim:

1. A positive electrode for use in a Electric Double Layer (EDL) Hybrid Electrochemical Capacitor (HEC), the positive electrode comprising:
 - a lead foil that is punctured serving as a current collector for the positive electrode; and
 - an active mass made up of lead dioxide (PbO_2) and lead sulphate (PbSO_4), wherein the active mass is applied to one or both sides of the lead foil.
2. The positive electrode according to claim 1, wherein the lead foil further has a three dimensional surface resulting from a surface treatment selected from the group consisting of being crimped, wrought and developed.
3. The positive electrode according to claim 1, wherein holes in the punctured lead foil have a total surface area that is less than 70% of a total initial surface area of the punctured lead foil.
4. The positive electrode according to claim 3, wherein holes in the punctured lead foil were made by needles inserted from one or both sides of the lead foil.
5. The positive electrode according to claim 1, wherein the lead foil is made of a lead alloy having alloying elements selected from the group consisting of silver, calcium, copper and tin, and combinations thereof.
6. The positive electrode according to claim 5, wherein the lead alloy further comprises additives to reduce corrosion.
7. The positive electrode according to claim 1, wherein the active mass is taken from a lead-acid battery.
8. The positive electrode according to claim 1, wherein the active mass is electrochemically formed directly within a EDL HEC from pastes of the types used in the formation of lead-acid batteries.
9. The positive electrode according to claim 1, wherein within the active mass, the lead dioxide and the lead sulphate ratio ranges from 1:0.1 to 1:2.5 by weight, respectively.

10. The positive electrode according to claim 1, wherein the active mass further comprises at least one binding agent.
11. The positive electrode according to claim 10, wherein the at least one binding agent comprises a polymer selected from the group consisting of PTFE, PVDF and proton-exchange polyfluorsulphonic acid of the Nafion type.
12. The positive electrode according to claim 11, wherein the active mass further comprises a filler material comprising glass fibers and thin cuttings of a separator material used in lead-acid batteries.
13. The positive electrode according to claim 1, wherein the active mass further comprises a dispersed porophore comprising graphite or ammonium bicarbonate.
14. The positive electrode according to claim 1, wherein the active mass is uniformly applied to one or two sides of the lead foil, and the entire positive electrode has been subjected to pressing and sintering at an elevated temperature.
15. An Electric Double Layer (EDL) Hybrid Electrochemical Capacitor (HEC) comprising:
 - the positive electrode of claim 1;
 - polarizable negative electrode;
 - porous dielectric separator interposed between the positive electrode and polarizable negative electrode;
 - current collector coupled to the polarizable negative electrode consisting of metal layers and a protective layers, wherein the protective layers are respectively interposed between the polarizable negative electrode and the metal layers;
 - liquid electrolyte contained in the positive electrode, the polarizable negative electrode and the porous dielectric separator; and
 - reinforcement plates that encase the positive electrode, the porous dielectric separator, the polarizable negative electrode, and the current collector.
16. The EDL HEC according to claim 15, wherein the negative electrode comprises at least one carbonaceous material.

17. The EDL HEC according to claim 15, wherein the protective layers comprise at least one non-porous carbonaceous material.
18. The EDL HEC according to claim 15, wherein the liquid electrolyte comprises a solution of sulfuric acid.
19. The EDL HEC according to claim 15, having at least one component providing at least partial offset and/or shock-absorption of a change in thickness of the positive electrode during cycling of the EDL HEC.
20. The EDL HEC, according to claim 19, wherein either the negative electrode or the porous dielectric separator, or both the negative electrode and porous dielectric separator, provide the at least partial offset and/or shock-absorption of a change in thickness of the positive electrode during cycling of the EDL HEC.
21. The EDL HEC, according to claim 19, further comprising at least one rubber gasket interposed between at least one of the reinforcing plates and at least one metal layer of the current collector for providing the at least partial offset and/or shock-absorption of a change in thickness of the positive electrode during cycling of the EDL HEC.